Reducing Fly Ash Emissions at the Vladivostok Municipal Waste-to-Energy Facility

Project Title: Clean Sky for Vladivostok: Incorporation of Environmentally Acceptable Air Pollution Control and Ash Utilization Technology at the Vladivostok Municipal Waste-to-Energy Facility
Leader: Vladivostok Municipal Waste-to-Energy Facility "Speczavod 1"
Partner: Energy & Environmental Consulting Engineers (EECE), Mission Viejo, CA, US
Location: Vladivostok, Russia
Project Duration: February 2000 – January 2001
EcoLinks Project Investment: Total Project Investment: $101,775; EcoLinks Grant Support: $50,000; Project Team Cost Share Contribution: $51,775.

Best Practice: Transferable Solution

The project “Reducing Fly Ash Emissions at the Vladivostok Municipal Waste-to-Energy Facility” is an EcoLinks Best Practice. It successfully identified options for reducing air pollution emissions associated with waste-to-energy facilities. The project results, including technical designs of pollution control equipment, are highly transferable to other waste-to-energy facilities throughout the Newly Independent States (NIS). The technical plans developed for fly ash control are also transferable to small-scale, steam generating coal incinerators in the NIS. The project further demonstrated that the implementation of relatively low-cost environmental measures simultaneously can produce significant economic returns. As a result of boiler efficiency improvements and pollution control measures, CO and SO_2 emissions were reduced by more than half and fly ash emissions were reduced by over 90%.

Increased boiler efficiency also increased steam production, and thus increased revenue for Speczavod.

Project Summary

Speczavod 1 is the only waste-to-energy facility in Russia Far East. It was built in a residential area of Vladivostok in 1979. The facility has three incinerators that were built to process up to 432 tons of unsorted municipal waste per day, and to produce almost 400,000 tons of steam annually for residential heat and hot water. Speczavod was originally equipped with electrostatic precipitator systems (EPSs) that originally captured approximately 80% of the fly ash. Due to the humid climate conditions in Vladivostok, however, the units deteriorated after ten years. Speczavod was built without controls for acid gas emissions.

Before the implementation of this project, Speczavod had a very negative public image and the previous city mayor had tried to close the facility. Speczavod was forced to run at less than full capacity due to unacceptably high fly ash emissions (approx. 2000 tons per year which is over 14 times higher than permitted levels). The facility emitted 232 tons of SO_x, 78 tons of NO_x and 84 tons of CO per year. Incinerator efficiency was low, and burning temperatures frequently dropped to 300-500C . Low incineration temperatures and high levels of organic material in Vladivostok's waste flow contributed to high dioxin emissions.

In January 2000, Speczavod and their American partner Energy & Environmental Consulting Engineers (EECE) were awarded an EcoLinks Challenge Grant to identify options for reducing pollution emissions at Speczavod. Speczavod secured funding to implement several of the recommendations from the EcoLinks-funded project that have resulted in significant decreases in fly ash emissions, dioxins, and CO and SO_2 emissions. The project also increased the efficiency of one of the incinerator units by 36%, which in turn resulted in significant economic benefits for Speczavod through increased steam production and sales and reduced auxiliary fuel purchase.

Project Activities

The overall objectives of the project were to: (1) address Speczavod's fly ash emission problem through development and installation of a fly ash capture system; (2) assess the potential for utilization of fly ash in concrete materials; (3) identify technical options for reduction of SO_x and NO_x pollution.

The project activities were as follows:

1. Generated support for the project

Action: During the initial stages of the project, the Project Team, including the American partner, met with local government officials, and the mayor of Vladivostok to lobby support for the project. The city administration agreed that if the project

developed realistic and low cost options, money could be secured from the municipal budget for implementation of the project recommendations.

Product(s): Initial agreement on follow-up funding.

2. Conducted baseline environmental and technical assessment

Action: Project associate Daltechenergo conducted a baseline environmental and technical assessment of Speczavod. Using a QUINTOX gas analyzer, Daltechenergo determined SO_2, NO_x, fly ash and CO emission levels. Annual pre-project emission rates for one incinerator unit were: 232 tons of SO_x, 84 tons of CO, 78 tons NO_x, and 2000 tons of fly ash. Another important finding of the technical assessment was that bag houses and Electrostatic Precipitation Systems (EPS) (the two most common fly ash capture systems) are not suitable for Speczavod. The Vladivostok climate is too humid for EPS units and the high content of calcium and food in the municipal waste processed at Speczavod generates acid gases that require special materials for bag houses and frequent replacement of EPS units.

Product(s): 1) A pre-project baseline of technical and environmental characteristics of Speczavod 2) Document, "Expert Conclusions on Speczavod's Technical and Ecological Characteristics" published and shared with the Regional Department of the Government Committee on Nature Protection (GosKomPrirody) 3) Emission quota standards for Speczavod set by GosKomPrirody. (Note: Emission quotas were needed before pollution reduction equipment could be selected.)

3. Modernized incinerator #2

Action: With funding from the Municipality of Vladivostok, Incinerator # 2 was modernized to ensure a more complete and stable burning process. Modernization included the installation of new incinerator tubes and an air heating system in the gas convection area, replacement of the main components of the slag removal equipment, reparation of the incinerator grate, modernization of the hydraulic equipment and incinerator framework, and installation of new electric generators.

Product(s): Modernized incinerator with optimal burning process.

4. Shared information on alternative pollution control measures, equipment, and standards

Action: Project partner EECE analyzed and provided Speczavod with information on American environmental controls on similar sized waste-to-energy facilities. EECE provided Speczavod with engineering options and designs of pollution control equipment from the following US manufacturers: BELCO Technologies, Environmental Elements Corporation, Wheelabrator Air Pollution Control, Research-Cotter, Procedair, and Western Precipitator. EECE researched and introduced the Project Team to acceptable US and European environmental standards.

Product(s): 1) Information on waste-to-energy facilities including environmental controls, engineering options and designs of pollution control equipment, literature on municipal waste combustion and ash, and review of US and European environmental

standards 2) Over 100 pages of literature on municipal waste combustion and ash translated into Russian and made available on the Cleansky website.

5. Visited waste utilization facilities in the US

Action: The director and chief engineer of Speczavod, and the director of International Programs, PIDET project associate, traveled to visit waste utilization facilities in Southern California. The group studied US technology, equipment manufactures, and US regulations and standards for operating solid waste management facilities. The trip was organized by EECE.

Product(s): 1) Russian translation of the information received during the trip on the use of phosphate additions in ash-based concrete slabs was translated into Russian 2) Cleansky web site publication of the translated information.

6. Tested fly ash composition

Action: Project associate Far Eastern Research Institute on Construction Testing Center Dalstroiipytania ran a series of tests on Speczavod fly ash composition to determine the appropriateness of its use in concrete materials and optimal processing. Testing demonstrated that Speczavod fly ash would be most suitable for use in asphalt/road construction. (Speczavod fly ash durability and water absorption characteristics are unacceptable for use in cement materials without additional processing).

Product(s): 1) Test data on Speczavod fly ash composition 2) Fly ash use possibilities.

7. Developed fly ash control system

Action: Daltechenergo developed technical plans and cost estimates of a fly ash control system. The fly ash control system designed by Daltechenergo is a two-phase system, consisting of a four-section precipitation camera and a battery of 16 cyclones. The total estimated efficiency of this system is 93%. EECE provided information to Daltechenergo on American fly ash control systems and reviewed EECE's plans. Applications for permits from GosKomPrirody to install the equipment were submitted in advance.

With follow-up funding secured from the Municipality of Vladivostok, a fly ash control system was constructed and installed on Incinerator #2 at Speczavod.

Product(s): Technical plans and economic analysis of fly ash control system.

8. Developed acid gas control system

Action: Using information provided by EECE, Daltechenergo studied available NOx and SOx gas control systems and developed recommendations for Speczavod. Daltechenergo recommended a dry scrubber lime-injection system to neutralize acid gases, complemented by limestone injection into the incinerator units. The main factors in considering technical options for acid gas control were (1) absence of space at Speczavod to house the wet or semi-dry scrubber equipment; and (2) limited water

resources to dedicate to a wet scrubber. The recommended system should bring acid gas levels down to approximately 35% of pre-project levels.

Product(s): 1) Study of available acid gas control systems 2) Recommendations for improved acid gas control.

9. Disseminated project results

Action: Created a web site, http://www.openuniversity.ru/cleansky, and an e-mail listserv for disseminating international experience on "greening" waste-to-energy facilities and on the project's achievements.

Product(s): 1) A project web site http://www.openuniversity.ru/cleansky 2) E-mail listserv.

Project Benefits

This project resulted in environmental, economic, and capacity building benefits. Capacity building benefits were achieved through the experience gained from participating in international and interdisciplinary working partnerships for transferring and applying new technology. As a result of this EcoLinks funded project, pollution emissions were reduced and economic benefits from increased efficiency and reduced environmental fines were generated.

Capacity Building Benefits

The capacity building benefits of this project were achieved through the experience gained from working in an international partnership context. This facilitates future cooperation with international partners and fundraising to achieve environmental and economic benefits. The Project Team met with local government officials, and the mayor of Vladivostok to lobby extended support for the project. This cemented cooperative links between Speczavod and the project partner and associates as well as between Speczavod and the local government.

Environmental Benefits

With additional funding from Vladivostok City Ecological Fund, Incinerator #2 was modernized. This modernization has already resulted in significant environmental improvements (reduction of dioxins, increase in energy efficiency) while producing economic benefits for Speczavod in the form of fuel savings and increased steam sales.

Table 1. Emissions Reductions with Modernization of One Incinerator Unit (total cost $52,000) (Completed)

Pollutant	Pre-project emission	Post-project emission
CO	84 tons per year	32.2 tons per year
SO_2	17.5 tons per year	2.5 tons per year

Dioxin emissions were also significantly reduced through improved temperature control in the incinerator (prior to the project, temperature levels fell to as low as 300C . After modernization of the incinerator, temperature is in the 900-1000C range), however, pre-project dioxin levels were not measured.

With project-follow-up financing from the Municipality of Vladivostok, the fly ash capture system designed through this project was constructed and installed on Incinerator #2. Fly ash emissions reductions are listed in Table 2.

Table 2. Emission Reductions with Installation of Fly Ash Capture System on Incinerator #2 (total cost $70,000) (Completed)

Pollutant	Pre-project emission	Expected Reduction
Fly ash	2000 tons per year	1820 tons per year

Table 3. Emission Reductions with Installation of Acid Gas Control System (total estimated cost $1,000,000) (Planned)

Pollutant	Pre-project emission	Expected Reduction
Sox	464 tons per year	108 tons per year
NO_x	156 tons per year	78 tons per year

Economic Benefits

Modernization of one incinerator unit increases over-all efficiency of the incinerator, and as a result, significantly less auxiliary fuel (mazut) is needed for the incineration process. Before incinerator modernization, approximately 1,700 tons of mazut were purchased at $114/ton for a total annual cost of roughly $190,000. After modernization, only 240 tons of mazut were needed, resulting in annual cost savings of over $160,000. Modernization of incinerator #2 also resulted in reduction of heat losses and a 36% increase in steam production. This results in potential increased steam sales of $70,000. Thus, the total economic benefit of modernization of an incinerator unit is $230,000 during one year of operation. The simple buy-back period of the $52,000 investment to upgrade the incinerator unit and boiler is about 4 months.

Installation of fly ash capture system on one incinerator unit will result in reduced environment fees equaling $52,000 year. The simple buy-back period of this $70,000 investment is 1.3 years.

Installation of acid gas control system is a significant investment ($1,000,000) with minimal direct economic benefits for Speczavod. Speczavod will seek grant funding to construct and install the acid gas control system.

Lessons Learned

Several lessons were learned during the implementation of this project. They include:

- American experience and pollution control engineering design can be transferred to NIS waste-to-energy facilities, but it must be adapted to local climatic conditions, budgetary constraints and specific waste streams.

- Most NIS municipal facilities, such as the Speczavod 1 waste-to-energy facility, have extremely limited budgets with which they can implement pollution control and efficiency improvement measures. Of primary importance is realistically assessing budgetary capabilities, prioritizing needs so that the most critical issues can be addressed, and being willing to upgrade part and parcel, as financing allows. Support from the municipal government and local environmental funds should be sought from the initial stages of the project.

- Most NIS municipal facilities, such as the Speczavod 1 waste-to-energy facility, have gone without even basic up keep for many years. Relatively low-cost upgrades and environmental controls on these facilities can have very significant environmental and economic impacts.

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